

ORIGINAL ARTICLE

Outcome of Minimally Invasive Plate Osteosynthesis in Distal Tibia Fracture: A Prospective Observational StudyBijay Bhujel, ¹Giri Raj Bhattarai, ²Ram Sharma Subedi, ¹Suman Kumar Shrestha³¹Department of Orthopedic and Trauma Surgery, National Trauma Center, Mahankal, Kathmandu, Nepal,²Tikapur Hospital, Tikapur, Kailali, Nepal,³Department of Orthopedic and Trauma Surgery, Patan Academy of Health Sciences, Lalitpur, Nepal

ABSTRACT

BACKGROUND

Various modalities of treatment have been advocated in literature for treatment of distal tibia fracture. Treatment is challenging because of poor soft tissue coverage and precarious blood supply. Minimally invasive plate osteosynthesis preserves fracture hematoma, and periosteum with less surgical trauma. The objective of this study was to evaluate the clinical and radiological outcome of minimally invasive plate osteosynthesis (MIPO) in distal tibia fracture.

METHODS

This was a prospective observational descriptive study conducted in Department of Orthopaedics and trauma surgery, Patan Hospital, from September 2019 to August 2020 after institutions review committee approval. Patient fulfilling the inclusion criteria underwent MIPO with anatomically contoured 4.5 mm locking compression plate. The associated distal fibula fixed with 3.5 mm reconstruction plate or 1/3 tubular plate or rush nail. Clinical and Radiological outcome were evaluated by using American Orthopaedic Foot Ankle Society score (AOFAS) and X-ray respectively. Statistical analysis was performed using EPI Info V7.2.2.2.

RESULTS

Fifteen (57.70%) patient had excellent, six (23.10%) had good and five (19.20%) had fair AOFAS score. Seven (27%) patient had valgus deformity. Mean time of partial and full weight bearing were 9.5±2.7 and 16.4±4.7 weeks respectively. Twenty one (80.80%) had union of the fractures within 26 weeks of surgery at mean time of 17.62 ±2.8 weeks and they return to work at mean time of 18.3±3.1 weeks.

CONCLUSION

MIPO is a reliable method of treatment for distal tibia fractures with high union rate and good functional outcome.

KEYWORDS

distal tibia fracture; minimally invasive plate osteosynthesis

INTRODUCTION

Treatment of distal tibia fracture is challenging.¹ It has poor soft tissue coverage and precarious blood supply.² At the beginning of modern era the bone fragments were extensively handled with wide exposure to gain access and to provide good visibility of fracture which lead to bone necrosis.³ Minimally invasive plate osteosynthesis (MIPO) preserves fracture hematoma, causes less surgical trauma, reduces operative time and infection rate.⁴ In 2015 study by Vidović D et al showed that MIPO is a reliable method of treatment for distal tibia fractures and it provides a

high union rate and good functional outcome with minimal soft tissue complications.⁵

This outcome analysis would provide an overview whether to continue the ongoing MIPO or think about other modalities like intramedullary nailing which has equivalent functional outcome in distal tibia fracture.⁶

The objective of this study was to evaluate the functional and radiological outcome of MIPO in distal tibia fracture..

METHODS

This was a prospective observational descriptive study conducted in patients admitted with distal tibia fracture in Patan Academy of Health Sciences (PAHS) from September 2019 to August 2020 after ethical approval from institutions review committee (IRC) of PAHS and the informed consent of the patient. Patient with age > 16 years presenting with distal tibia fracture

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(with or without simple intra articular extension (43A, 43B), type I and II open distal tibia fracture, with or without associated distal fibula fractures) were included in the study.

Patient with type III open fracture, poor local skin conditions (like hemorrhagic blisters, superficial skin infections), pathological fractures, associated systemic illness (like uncontrolled diabetes mellitus, rheumatoid arthritides), neurological or vascular injury, previous trauma to same limb, hip or spine problem affecting the gait, patient with compartment syndrome, patients not willing to participate in the study or lost to follow up were excluded from the study.

Minimum sample size was calculated using the formula given below by using OpenEpi, Version 3, and open source calculator SSPropor:

$$n = \frac{DEFF * Np (1-p)}{[(d^2/Z^2(1-\alpha/2*(N-1) + p*(1-p))}]$$

n=required sample size

N=Population size (for finite population correction factor):1000000

DEFF=Design effect (for cluster surveys-DEFF): 1

z=confidence interval (1.96 for 95% confident interval)

d=margin of error (0.05 for 5% error)

p=estimated prevalence

Prevalence of distal tibia fracture is 3%⁷

Here,

$$n = \frac{(1 * 0.03 * 1000000 (1 - 0.03))}{(0.05^2 * 1.96^2 * (1000000 - 1) + 0.03 * (1 - 0.03))}$$

n=45

Sample size: 45

Patients fulfilling the inclusion criteria underwent MIPO Intra-articular fracture if present reduced under C arm guidance and temporarily held with K wire. The anatomically countered 4.5mm locking compression plate (LCP) was inserted extraperiostally after creating a tunnel in a retrograde manner under image intensifier guidance. Small counter incision was made proximally to optimally align the plate on tibia and fixed with percutaneously placed screws by stab incisions under image intensifier guidance. At least three locking cortical screw of size 5 mm and 4 mm were inserted on either side of fracture proximally and distally respectively (cancellous screw used distally). The associated distal fibula was fixed with 3.5mm reconstruction plate or 1/3 tubular plate or rush nail

Post-operative follow up as per department protocol: (2nd week, 6th week, 13th week and 26th week) was done. Wound inspection was done on 2nd post-operative day Ankle and knee mobilization was started on 2nd day and the patients were discharged on 3rd post-operative day if surgical site was healthy else managed accordingly Suture removal was done on 14th post-operative day. Partial weight bearing with crutches was allowed from six weeks of surgery then gradually progressed to full weight bearing Radiological and clinical examination was done in 6th week, 13th week and 26th week, as per the follow up protocol of our department. Patient was advised for non-weight bearing until radiological evidence of union (Visible bridging callus on three out of four cortices across the fracture in the AP/lateral X-ray view) was found. Once radiological union was started, partial to full weight bearing was allowed. All cases were assessed for functional outcome using AOFAS at the end of 26th week.⁸

The AOFAS as a complete scale has been shown to be responsive and valid in its original language version.⁹ AOFAS remain in

use as substantially higher rate than other scales that have been validated because it is easy to apply and understand because of its wide use in literature.⁸ However its weakness is that it is partly a clinician based survey and such surveys are unlikely to fully reflect patient's feelings or functions.

AOFAS has nine questions divided into three components: 1. Pain, 2. Function, 3. Alignment

Total score possible for a patient is 100. Alignment of the foot and range of motion of the ankle (measured by orthopedic goniometer) is completed by the examiner on clinical assessment and assessing the radiographs. The other questions are completed by patients. The individual scores are then added together to obtain an overall functional outcome, expressed in percentage of the normal (100 points). Higher the score, better is the result. There had been concerns regarding interpretation of scoring received from a patient by using AOFAS score as there was no numerical value to define arbitrary subgroups when this tool was developed. Hence arbitrary subgroups excellent (score 90-100), good (80-90), fair (less than 80) was assigned to address this concern.¹⁰

Radiological assessment

Radiographic assessment was done by studying the conventional AP (antero-posterior) and lateral view of affected leg. The view should incorporate both adjacent joint i.e. both ankle and knee joint. The varus and valgus angle was calculated with the help of Paley and Tetsworth method where two horizontal lines will be drawn over tibial plateau and tibial plafond.¹¹ The midpoint of these two lines will be connected. Another perpendicular line was drawn over tibial plafond. The angle formed between these perpendicular line and line joining the midpoints of tibial plateau and plafond in AP X-ray view gave varus/valgus angle while on lateral X-ray view gave procurvatum/recurvatum angle.

Working definition

Return to work: Time duration chosen as the point at which the patient making an uncomplicated recovery would be expected to return to their normal daily activities.⁹

Distal tibia fractures: Fracture of the distal 1/3rd of the tibia present up to 11cm above the tibial plafond.¹²

Consistent bony union: defined based on two criteria.¹³: 1. The ability of the patient to bear weight without pain, 2. Visible bridging callus on three out of four cortices across the fracture in the AP/ lateral X-ray view.

Malunion: 1. Varus or valgus deformity of more than 5 degrees, 2. An antero-posterior angulation of more than 10 degrees, 3. A shortening of the limb more than 1 cm.

Delayed union: defined as failure of fracture union by 6 months after surgery.¹⁴

Statistical analysis was performed using EPI Info V7.2.2.2. Descriptive statistics were done using frequencies with percentages for categorical variables. Mean and standard deviation were used for continuous variables.

RESULTS

This study was conducted for twelve months from September 2019 to August 2020 in PAHS. We had less number of patients than estimated sample size because of COVID pandemics which lead to nationwide lockdown resulting in restricted outdoor activity and travelling which may have contributed in decreasing accident and injury prone activities. However we had included all the cases who

underwent MIPO of distal tibia fracture in the study period in our study center which was 27. One patient lost to follow up during the study period Thus, only twenty six cases were included in the study.

The mean age of the participants was 47.35 ± 15.2 years. Out of total 26 patients, 16 (61.50%) were female whereas male patient comprised of 10(38.5%) of total cases. (Table 1)

Table 1: The demographic profile of patient with distal tibia fracture

Patient particular		n (%)
Sex	Male	10(38.50)
	Female	16(61.50)
Age group	11-20	1(3.85)
	21-30	3(11.54)
	31-40	5(19.23)
	41-50	7(26.92)
	51-60	7(26.92)
	>60	3(11.54)

The mean partial weight bearing time and full weight bearing time was found to be 9.5 ± 2.7 weeks and 16.4 ± 4.7 weeks respectively.

Seven patients had malunion (valgus deformity of greater than five degree) while no obvious varus, procuratum, recurvatum deformity or shortening of greater than one cm.

Twenty one patients who had bony union, had mean fracture union time of 17.62 ± 2.8 week and their mean time to return to work was 18.30 ± 3.1 week. One patient had to undergo implant removal at three month due to deep infection with exposure of implant and two patient underwent debridement for superficial skin infection whereas two patient had no underlying cause for delayed union except that they are smokers.

The mean AOFAS Score calculated at the end of 26th week was 85.85 ± 6.6 Fifteen patients had an excellent outcome following MIPO surgery following distal tibia fracture which is discuss in table 2.

Table 2: Functional Outcomes of MIPO in distal tibia fracture using AOFAS score

Outcome	Number	Percentage (%)
Excellent	15	57.7%
Good	6	23.1%
Fair	5	19.2%
Total	26	100.0%

DISCUSSION

Distal tibia fractures are a dilemma for orthopedic surgeons in terms of management. Various modalities of treatment have been advocated. If surgical treatment is decided on, the second question arises as to the type of fixation method: external fixation, open reduction and plate fixation, MIPO, or intra medullary nailing (IMN), which can all be used as the definitive surgical treatment. It should be remembered that fracture

treatment method should provide anatomic or at least acceptable fracture alignment in the tibia, because any mal-alignment or mal-rotation may cause posttraumatic osteoarthritis in ankle and knee joints in the long term.¹⁵

In our study, Fifteen (57.70%) patient had excellent, six (23.10%) had good and five (19.20%) had fair AOFAS score. Seven (27%) patient had valgus deformity. Mean time of partial and full weight bearing were 9.5 ± 2.7 and 16.4 ± 4.7 weeks respectively. Twenty one (80.80%) had union of the fractures within 26 weeks of surgery at mean time of 17.62 ± 2.8 weeks and they return to work at mean time of 18.30 ± 3.1 weeks.

The mean AOFAS Score calculated in our study was 85.85 ± 6.6 which is less as compared to study by Paluvadi SV et al (AOFAS score: 90.06), Jha RK et al (AOFAS score: 93).^{16, 17}. This may be due to earlier calculation of AOFAS score in our study as compared to Paluvadi SV et al and Jha RK et al where they had calculated AOFAS score at the end of three year follow up and not to forget that AOFAS is partly a clinician based survey and such surveys are unlikely to fully reflect patients feelings or functions. Hence, the component of AOFAS score like pain and function may improve with time and physiotherapy resulting in higher AOFAS score.

But our AOFAS score was similar to Collinge et al. (AOFAS score: 83).¹⁸ They have calculated AOFAS score at the end of two year and also included grade III open fracture in their study.

Out of 26 patients in our study, 21 patients had union of fracture at 17.62 ± 2.8 week. Five cases had delayed union. The reason for delayed union is due to surgical site infection. One patient had to undergo implant removal at three month due to deep infection with exposure of implant and managed with external fixator and two patient underwent debridement for superficial skin infection. While two patient had no obvious reason for delayed union except that they are chronic smoker.

The union time was similar to study conducted by Onta PR et al (17.75 w), Jha RK et al (16.63 w) and Guo et al. (17.6 w).^{17, 19, 20}

Seven patient had valgus deformity of greater than five degree while no obvious varus, procurvatum, recurvatum deformity or shortening of greater than one cm. These valgus deformity was seen in patient with comminuted fibula fracture where fibular length was difficult to maintain.

Considering other variables, we have found less blood loss, less fluoroscopy time, shorter duration of operation and smaller incision length in the MIPO technique. Saphenous nerve and vein injuries have been reported in studies but we had few cases with saphenous vein injury in our study but not saphenous nerve.²¹ Exact number of patient with saphenous vein injury couldn't be documented as they are not mentioned in post-operative note.

The limitation of this study is its small sample size. Sample size we collected is small as compared to calculated sample size. We acknowledge that the inadequate sample we collected will have impact on the implications of the study's statistical power and generalizability of the study and this is the limitation of this study. Due to various modalities of treatment available for distal tibia fracture both surgeon and patient opted for other modalities of treatment rather sticking to MIPO and not to forget the COVID pandemic decreasing the patient flow as well as irregular follow up. Different modalities for fixation of fibula were used during our study which may again have impact on functional outcome of MIPO.

Validation of AOFAS tool couldn't be done due to time constrain

The other limitation is preoperative X-rays and immediate post op

X-rays were not adequately showing the proximal knee joint for mal-alignment angle measurement. In such case we used the midpoint of the shaft as reference for upper end and midpoint of plafond as reference for lower end

The study period was one year and functional score was calculated at end of six months which was very short duration for proper functional outcome analysis.

Outcome analysis would be more helpful in defining the treatment modalities, if we had sufficient sample treated with different modalities like external fixation, open reduction and plate fixation, MIPO, or IMN and their outcome were compared.

CONCLUSION

MIPO is a reliable method of treatment for distal tibia fractures with high union rate and good functional outcome in short term outcome analysis.

CONFLICT OF INTEREST None

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